2005

GREATER SANDHILL CRANE: RESEARCH AND MANAGEMENT IN CALIFORNIA SINCE 1978

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Abstract: The greater sandhill crane (*Grus canadensis tabida*) was added to the California list of threatened species in 1983, and the subspecies has been the subject of research and management actions instituted by the California Department of Fish and Game (hereafter Department). Since 1978, the Department has conducted research and recovery actions including periodic breeding ground and wintering area studies, population monitoring, participated in developing Pacific Flyway crane management plans, acquisition and management of key habitats on breeding and wintering grounds, and developed a draft greater sandhill crane recovery strategy. These tasks were accomplished with the assistance of crane researchers and wildlife managers from throughout the United States. Highlights of the Department's program of research, management, and planning activities for greater sandhill cranes are presented. Breeding ground studies indicate a population > 450 pairs exist on private and public lands, primarily in 6 northeastern California counties. Recruitment averaged 5.7% (1.7 sd) in the 1980s-90s. The Department continues actions to facilitate recovery of this threatened subspecies. Threats to cranes and their habitat that may impede recovery efforts are discussed.

PROCEEDINGS NORTH AMERICAN CRANE WORKSHOP 9:155-165

Key words: breeding, California, greater sandhill crane, *Grus canadensis tabida*, management, monitoring, planning, population threats, recruitment, research, recovery strategy, threatened species, wintering

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In 1983, the California Fish and Game Commission added the greater sandhill crane (*Grus canadensis tabida*) to the State list of threatened bird species. Prior to, and since its listing, the greater sandhill crane has been the focus of a comprehensive Departmental program of research, management, planning, and recovery activities throughout its breeding and wintering ranges in the State. Beginning in 1978, this program has benefited from the assistance of several state and Federal agencies, academics, and the private sector, both inside and outside of California. Notable partners have included the U.S. Fish and Wildlife Service (USFWS) and the U.S. Forest Service (USFS). The Nature Conservancy (TNC) and the State Wildlife Conservation Board (WCB) have played important roles in the acquisition of key crane habitats on breeding and wintering grounds. Researchers from academia and the private sector have participated in important studies. Some private land owners have contributed to the conservation of cranes through sensitive management of habitats on their farms and ranches. Before its listing as a threatened species, the greater sandhill crane had been identified as warranting special consideration; it was an Audubon Red Book species in the 1980's, it had been selected for Pacific Flyway management planning in 1978, and it was included on the Department's Bird Species of Special Concern in California during 1978-82. The objectives of this paper are to provide an overview of research and management activities and recovery efforts to improve the status of the greater sandhill crane in California.

BREEDING AND WINTERING DISTRIBUTION AND ABUNDANCE

Breeding Grounds

Historical notes indicate California's breeding population of greater sandhill cranes nested in eastern Siskiyou County, northeastern Shasta County, and south to Honey Lake, Lassen County. Breeding records were from near Ft. Crook, Shasta County (1860), and Eagleville near Alturas, Modoc County (Grinnell and Miller 1944). Walkinshaw (1949) estimated that 3-4 pairs had territories in California in 1944; however, no range wide searches for crane territories were conducted during those earlier years. Historically, breeding records tended to be from incidental sightings, not suitable for developing past to present population trend data.

Recent surveys have been more intensive. Baseline population estimates have been developed from increasingly intensive surveys in 1971, 1981, 1988, and 2000 (Littlefield 1982, 1989; Littlefield et al. 1994; Ivey and Herziger 2001; Table 1; Fig. 1). Recent surveys revealed that wetland and meadow habitat on private and public lands in Lassen, Modoc, Plumas, Shasta, Sierra, and Siskiyou counties constitute the current breeding grounds in California. In the 2000 survey (Table 1) 465 breeding pairs were recorded as follows: Modoc (252), Lassen (122), Siskiyou (51), Plumas (20), Shasta (10), and Sierra (10). Breeding pair estimates have ranged from 112 breeding pairs in 1971 in 3 of the above 6 counties to 465 pairs in 2000 in 6 counties (Table 1).

Wintering Grounds

After young fledge, cranes concentrate at grain fields near favorable roost sites. They confine most of their activities within these habitats until fall migration. Important fall foods include barley, rye, wheat, and oats. Fields used consistently by cranes are often within 6 km of a shallow wetland which serves as a

Table 1. Greater sandhill crane breeding population estimates in 6 northeastern California counties (Lassen, Modoc, Plumas, Shasta, Sierra, and Siskiyiou), 1971-2000.

Year	Survey months	Breeding pairs	Source
1971	March-April	112[a]	Littlefield et al. 1994
1981	March - May	191[b]	Littlefield 1982
1988	March - August	277[b]	Littlefield 1989
2000	April - June	465[b]	Ivey and Herziger 2001

[a] **Lassen, Modoc, Shasta counties only**
[b] **Lassen, Modoc, Plumas, Shasta, Sierra, and Siskiyiou counties.**

communal roost site (Littlefield 1986).

Once cranes leave pre-migration staging areas, they fly south to southwest to wintering grounds in the Central Valley of California from near Chico, Butte County, south to Delano, Kern County (Fig. 2; Littlefield and Thompson 1979, Pogson 1990, Pogson and Lindstedt 1988, 1991; Pacific Flyway Council 1997). Small numbers (< 1000) of Lower Colorado River Valley Population (LCRVP) of greater sandhill cranes primarily winter in Imperial County, California (Fig. 3; Pacific Flyway Council 1995). These cranes breed mainly in Utah and Nevada, and most winter in Arizona. Flocks of lesser sandhill cranes (*G. c. canadensis*) and some Canadian sandhill cranes (*G. c. rowani*) also winter in the Central Valley.

Suitable roosts and nearby abundance of cereal grain crops are requisites for wintering cranes. Rice is the most important food crop for wintering cranes in the northern Central Valley and corn is used on the remainder of the wintering ground, particularly in the Sacramento-San Joaquin River Delta (hereafter Delta) (Littlefield and Thompson 1979, Pogson and Lindstedt 1988). Irrigated pastures also are used extensively as loafing and feeding sites at some areas (Pogson and Lindstedt 1988). Both the abundance and availability of agricultural food crops are critical for cranes wintering in California.

Attempts to estimate the wintering population of greater sandhill cranes are difficult because 3 currently recognized subspecies annually inhabit the Central Valley from about mid-September to early March. However, several researchers obtained winter sandhill crane population estimates at various locations in the1960s- early1990s (Table 2).

RESEARCH AND MONITORIING

Early Activities

Prior to establishing the Department's coordinated research program in 1978, there were a number of incidental and systematic sources of information used to track the status of cranes breeding and wintering in California. From the 1940s-50s and continuing to the present, Department, other agency, and private sector individuals reported sightings of cranes on both breeding and wintering grounds (Naylor et al.1954, Littlefield 1973). Since about 1960, during aerial breeding and wintering waterfowl surveys, Department personnel recorded cranes along with ducks and geese. Various individuals have conducted studies on breeding and wintering crane populations, with the most notable studies in the 1970s-80s (Littlefield 1973, Littlefield and Thompson 1979, Pogson and Lindstedt 1988). Herter (1982) conducted a lesser sandhill crane banding study in the Central Valley, and Pogson (1990) and Pogson and Lindstedt (1988, 1991) studied crane winter habitat use in the Central Valley.

1978-Present Activities

In 1978, the Department initiated its crane research and monitoring program on both the breeding and wintering grounds; Department personnel also participated in developing Pacific Flyway Management plans for all cranes breeding and wintering in California. Plans focusing on the greater subspecies initially formed the basis for the Department's research and management activities, and later, they served as a model for

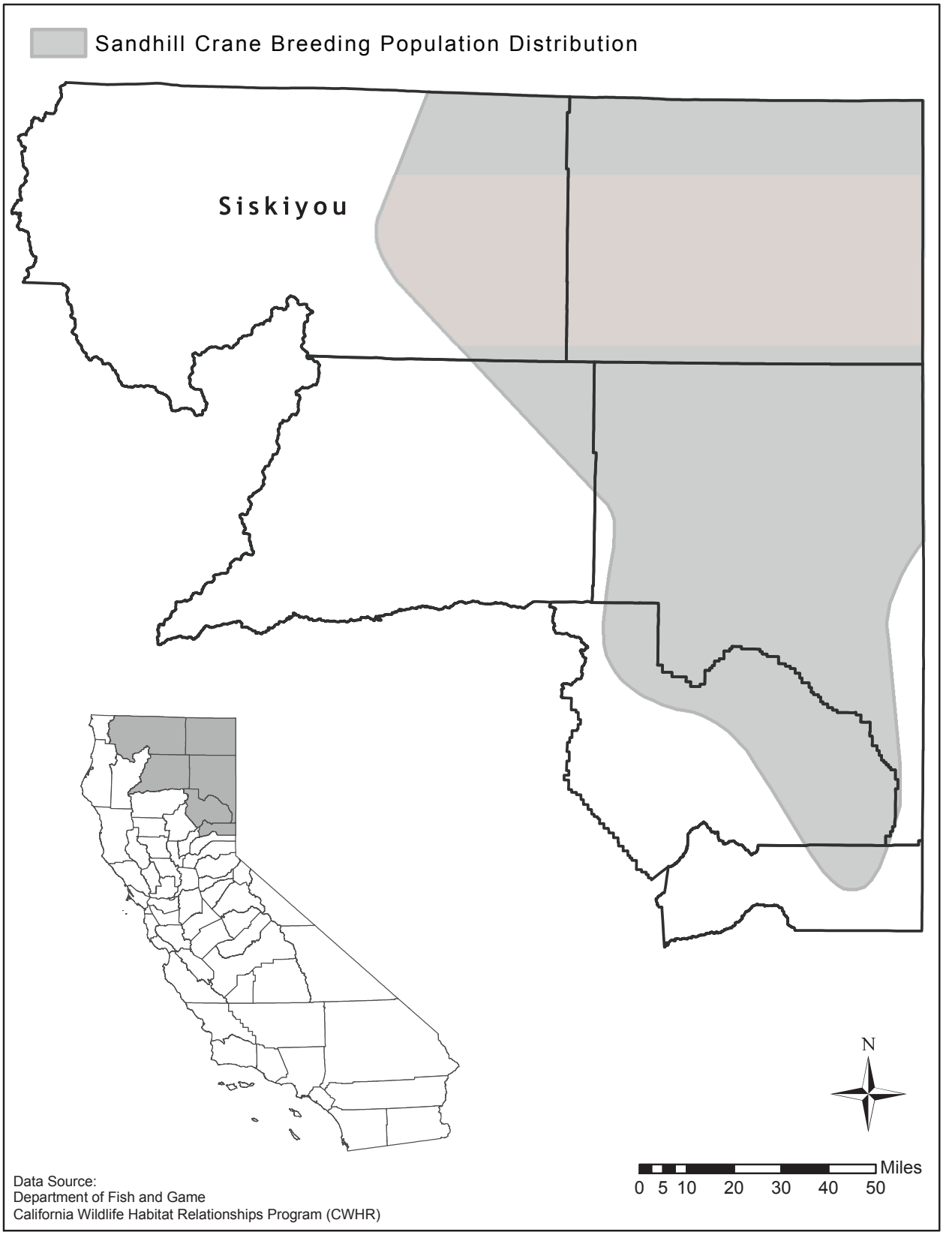

Fig. 1. Breeding distribution of greater sandhill cranes in California.

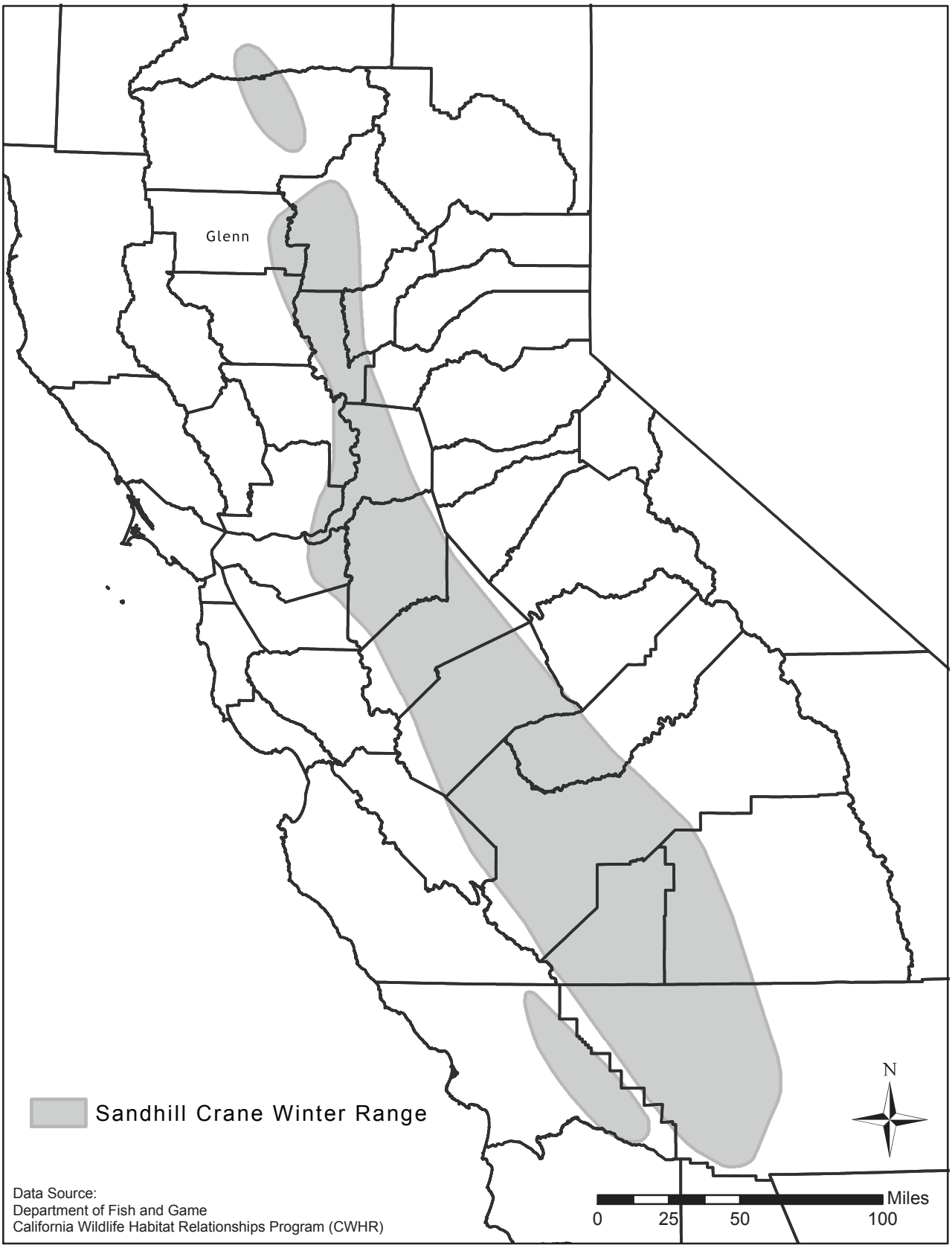

Fig. 2. Winter distribution of the Central Valley Population of greater sandhill cranes in California.

Fig. 3. Winter distribution of the Lower Colorado River Valley Population of greater sandhill cranes in California.

Table 2. Sandhill crane wintering population estimates, Central Valley of California, 1960s-2000.

Year	Location	No. cranes	Source
1960's to 70's	Butte Sink[a]	3,000-3,200[b]	Littlefield and Thompson 1979
1983-84	Central Valley	6,800[c]	Pogson and Lindstedt 1994
1991-92	Butte Sink	4,900-6,800[b]	Littlefield 1993
2000-01	Delta[d]	6,000-14,000[e]	Schlorff 2001

[a] **Butte and Sutter counties, all subspecies**
[b] **Reported as greater subspecies**
[c] **Reported as "large cranes"**
[d] **Sacramento-San Joaquin Delta**
[e] **Five aerial counts by the author; all 3 subspecies included**

recovery planning in the State (Pacific Flyway Council 1995, 1997). A 1981 breeding ground study, primarily in the northern counties of Modoc, Siskiyou, Lassen and Shasta, found a small population of greaters nesting primarily on private lands (Littlefield 1982, Table 1); additional cranes were scattered on National Forest lands. This study built upon Littlefield's (1973) earlier research in 1971 on some of the same areas (Table 1). Following the 1981 study, key breeding areas were periodically monitored (Schlorff 1987) by both ground and aerial surveys.

In the late 1970s-80s, the Department also began annual air and ground monitoring of wintering cranes to locate concentration areas, determine habitat use, identify key roosting areas, record marked bird observations, and obtain winter population recruitment estimates (Schlorff 1981, 1982, 1987; Table 3). In 1983-84, Department personnel attempted to capture and mark greater sandhill cranes at several wintering locations, but this was unsuccessful due to the difficulty in attracting cranes to baited trapping sites when abundant food was available elsewhere (Schlorff 1987).

While the Department was initiating studies in California, there already was a program of ongoing research and banding at the Malheur National Wildlife Refuge (NWR), Oregon (Littlefield 1968, Littlefield and Ryder 1968, Littlefield 1976). In the 1980's and 1990's color-marking continued at Malheur NWR, and also began at the Modoc NWR, Modoc County, California, in cooperation with the Department's crane research program (Littlefield 1985, Des Roberts 1992, 1997). Many observations of cranes banded at these 2 refuges were made by Department personnel on Central Valley wintering sites. The cooperation between NWR personnel in Oregon and California was critical in assisting the Department's ongoing and expanding crane research and management programs. Additionally, banding and other breeding ground research were conducted by TNC at the Sycan Marsh in southern Oregon during the 1980s (Stern et al. 1986).

Although Department research and monitoring activities have continued to the present, annual efforts have not been consistent. Highlights of research and monitoring include some recent comprehensive studies on both the breeding and wintering grounds in California (Littlefield 1993a,b, Littlefield et al. 1994, Ivey and Herziger 2001, 2003). This may partially be explained by Department's recent effort to write a recovery plan for greater sandhill cranes, but there have been data gaps in the 1990s-2000s that have hindered plan development (CDFG, Recovery Planning Strategy for the Greater Sandhill Crane, in preparation). For example, an accurate wintering population estimate for all 3 subspecies of sandhill cranes is critical for setting a recovery target number for greaters.

Contrasting the difficulties of obtaining wintering population estimates by subspecies, breeding ground research has been less challenging because only the greater subspecies nests in California. However, because of problems associated with accurate identification of 3 subspecies, their relative winter population number estimates do not exist. Breeding ground studies completed in the 1970s-80s showed a lower crane population than estimated in 2000 (Table 1). But these results, ranging from 122 pairs in 1971 to 465 pairs in 2000, also suggest differential survey effort has biased estimating the number of breeding cranes in California. The apparent increase may not be all due to breeding population growth since earlier surveys involved much time and effort in locating breeding pairs and sites used. Later surveys solved some of these problems with the use of aircraft. However, Littlefield et al. (1994) reported individual breeding locations, within the larger northeastern California study area, where crane pairs did increase from 1971 to 1981 and again in 1988. When the fourth population estimate was made in 2000, these same 5-6 sites continued to show an increase in breeding pairs (Ivey and Herziger 2001). Additional monitoring will be necessary to refine methodology, assess population estimates, and to track the subspecies recovery in

the State.

THREATS TO CRANES AND MANAGEMENT RECOMMENDATIONS

Existing Management for Sandhill Cranes

Since its listing as a threatened species in 1983, the greater subspecies has received elevated management attention in California (Schlorff 1994, Pacific Flyway Council 1995, 1997). In addition to improved crane management on existing NWRs and State Wildlife Areas (WAs), additional habitat has been acquired by state and federal agencies and the private sector. This has included Department recommended land acquisitions in Modoc and Lassen counties (Ash Creek WA) and in the San Joaquin Valley (Woodbridge Ecological Reserve) in the 1980s. Some wetland easements include the Natural Resource Conservation Service Water Bank Program, which has temporarily protected some crane territories in Modoc County. Lands managed under the NWR system and TNC preserve properties have provided additional habitat on both breeding and wintering grounds in California (Littlefield and Ivey 2000). National Forest lands, particularly in Lassen and Modoc counties, also provide important crane breeding habitats (Littlefield 1982, 1989, Ivey and Herziger 2001).

A program of breeding habitat acquisition and other management strategies, on both private and public lands, to protect wetlands used by nesting greater sandhill cranes will be essential in achieving recovery objectives. Cranes generally are found breeding and wintering in natural wetland ecosystems and also use certain agricultural lands, therefore, by protecting these habitats additional species, including waterfowl and other birds, could also benefit.

Private Land-Use

Increased demand for crops such as alfalfa could lead to extensive private land conversions in the primary crane breeding areas. Such land use conversions could eliminate breeding cranes from some private lands in California. Pursuing large scale acquisitions may not be as practical as on the wintering grounds, although it may be an important management strategy for ensuring the protection of critically important breeding habitat. Acquiring conservation easements and purchasing key parcels of private land from willing sellers could help recover the greater subspecies in the state. If the current small breeding population is to be increased in the near future, it will be necessary to maximize crane production on certain public lands.

Wintering cranes in the Central Valley currently depend on certain agricultural practices and cropping patterns that are compatible with their daily and seasonal foraging and non-foraging activities (Pogson and Lindstedt 1988, 1991). Cranes concentrate primarily on private lands and are vulnerable to land-use changes that alter feeding, loafing, and roosting habitats (Pogson and Lindstedt 1988, Littlefield 1993a, Schlorff 1994). Other than purchasing key parcels to ensure that critical roosting and loafing sites are available and free from disturbance, there is relatively little habitat on private lands that can be protected or actively managed specifically for cranes by governmental agencies. Most important feeding areas are on large private lands in the Central Valley. The only means that governmental agencies have to ensure continued availability of these lands for cranes may be through cooperative agreements, purchase of conservation easements, and other incentives to induce private landowners to manage a portion of their lands for cranes. The private sector, therefore, clearly holds the key to the future survival of crane populations on both the wintering and breeding grounds in California.

Waterfowl Management Impacts

The Department has acquired lands that once supported large flocks of foraging cranes. Rogers (1990) reported that 90% of the Little Dry Creek Unit (LDCU) of the Upper Butte Basin WA was cultivated rice land and had been documented as important foraging habitat for cranes before its conversion to wetlands for waterfowl (Pogson and Lindstedt 1988, 1991). Thus, management actions to create wetlands, to provide waterfowl habitat and hunting opportunity, should be designed to minimize potential conflict with the requirements of sandhill cranes wintering in the same areas.

Littlefield (1993b) conducted research on crane foraging habitats and potential conflict with public use, including hunting and other activities, at State WAs. Littlefield (1993b) also investigated the impact of human disturbance on cranes at LDCU and surrounding agricultural fields. His findings indicated that disturbance due to all forms of human activities are often sporadic, short in duration, and potentially controllable. Human disturbance probably can be reduced further by specific management actions, including adjustments in timing and locations of hunting areas, and screening of disturbing activities from crane use areas by planting concealing vegetation such as willows (*Salix* spp.).

Conversion of certain croplands to seasonal wetlands on WAs and elsewhere, primarily for waterfowl hunting, has reduced availability of crane foraging habitat in the Central Valley (personal observation). A percentage of cropland, such as rice, needs to be available to cranes to fulfill their foraging habitat requirements on the wintering ground. However, even with an abundance of rice fields, flooding them beyond a certain depth makes the waste grain unavailable to foraging cranes (Littlefield 2002). It is important to acquire, in fee title and through conservation easements, additional lands and apply management sensitive to the habitat requirements of cranes. Existing public lands that support cranes could be enhanced with proper management of natural and agricultural habitats. The challenge now facing the Department, and certain NWRs, is to provide a balance of habitats to meet the needs of greater sandhill cranes

on private and public lands in concert with reducing conflicts caused by certain human activities, such as hunting. Since many of these lands currently or potentially can have a great number of wintering cranes, the recovery of the greater subspecies in California may depend upon successfully meeting this challenge.

Predation

Predation has limited sandhill crane productivity at Malheur NWR (Littlefield 1985, Littlefield and Cornely 1997, Ivey and Scheuering 1997). When lethal control was implemented, it reduced the impact of certain predators on nesting cranes (Littlefield and Cornely 1997). Predation trends in California involving coyote (*Canis latrans*), common raven (*Corvus corvax*), and raccoon (*Procyon lotor*) should be monitored closely and selected predators controlled if necessary (Littlefield 1989). Common ravens have increased significantly throughout the crane nesting range in California since 1981, and coyotes were regularly seen in many nesting areas in 1988, particularly Ash Valley, Lassen County, Sierra Valley, Plumas and Sierra counties, and lower Klamath NWR, Siskiyou County (Littlefield 1989, 1995). Nagendran (1993, 1994) found that low water levels in nesting wetlands increased losses to predators, such as coyotes; at Ash Creek WA, only 2 of 22 young cranes fledged in 1993. While predator control, principally for coyotes, occurs on many private lands, it also may be needed on certain public lands that support nesting cranes in the State. Actions to reduce predation on cranes at Malheur NWR have resulted in significantly improved nesting success (Littlefield and Cornely 1997; Littlefield 2003). Crane productivity needs to be periodically monitored; if it is found that persistently low recruitment rates are occurring in particular regions, then more intensive nesting studies should be initiated. California crane recruitment is low compared to other populations (Schlorff 1994, Drewien et al. 1995, Table 3), thus annual recruitment surveys are needed. If predation is deemed a major factor affecting crane recruitment, then control measures may be warranted.

Collision Mortality

Power line marking devices have been used successfully on Modoc NWR to reduce collision mortality in cranes (C. Bloom, U.S. Fish and Wildlife Service, personal communication). Marking devices often include large orange plastic globes attached at intervals on power lines coinciding with known regular flight paths. However, few of these devices have been used within the California crane nesting and wintering areas. Although power line marking devices are important for reducing collision mortality in crane nesting areas, they also may be especially needed near winter roosting and feeding sites in the Central Valley. As many as 22 cranes were killed in a single day as birds were leaving a roost site on a foggy morning (T. Pogson, personal communication). Most likely this type of loss can be reduced with power line markers. Power line mortalities have been reduced at some crane concentration areas in Oregon, Colorado, New Mexico, Wyoming, and the Modoc NWR, California with line marking devices (Brown and Drewien 1995, D. Lockman, Wyoming Game and Fish Department, and C. Bloom, U.S. Fish and Wildlife Service, personal communication). In cooperation with utility companies, a marking program should be tested on perennial problem power lines in the Central Valley wintering area to assess their effectiveness.

RECOVERY PLANNING

Background and Existing Actions

Since 1978, the Department participated with other Pacific Flyway states to develop crane management plans. These plans also could be modified to produce a recovery plan in accordance with the 1997 amendments to the California Endangered Species Act (CESA). Specific management recommendations are contained in the Pacific Flyway Management plans for the CVP and LCRVP greater sandhill cranes (Pacific Flyway Council 1995, 1997). Those portions of Pacific Flyway Plans germane to California could, with refinements, form the basis for a recovery planning and implementation schedule for the State. The Pacific Flyway Plans contained several recommended research and management tasks that would be necessary for recovery of the greater subspecies in California (Pacific Flyway Council 1995, 1997).

When the greater sandhill crane was added to the list of threatened species in 1983, all populations breeding or wintering in the State were protected by CESA. This listing action was the first recovery step for the subspecies. The CESA provides that any activities that benefit or impact the subspecies be scrutinized by the State to protect crane populations and their habitats. The CESA also specified that appropriate steps be taken that would lead to recovery and delisting of the subspecies in California in a timely fashion.

Several years before the 1997 amendments of CESA required a formal recovery planning strategy for listed species (California Department of Fish and Game 2003), the Department had already taken some important steps toward the recovery of the subspecies by acquiring key habitats that had been identified as important for both nesting and wintering cranes (Littlefield 1982, 1989; Pogson and Lindstedt 1988, 1991). Two winter roost site acquisitions were funded by the Wildlife Conservation Board in 1985-87 based upon Department recommendations from wintering ground studies in San Joaquin County (Schlorff 1981, 1982, 1987). On the breeding ground, State WAs are to consider the needs of cranes in management of those lands. The Ash Creek WA, was identified as a key breeding area by Littlefield (1982, 1988), and is currently the largest State WA supporting breeding cranes.

Recovery Goal and Strategy

The ultimate goal of the California greater sandhill crane recovery strategy is to improve the status of the subspecies through a variety of specific habitat protection and other actions so that protections provided by CESA are no longer necessary, and delisting can be proposed (California Department of Fish and Game 2003). To accomplish this objective, the Department assembled a recovery team composed of members with various expertise and special interests. The Recovery Strategy Team had representatives from state and federal agencies, conservation groups, and private land owners. Species recovery is dependent upon specific actions in areas of habitat protection, habitat management, habitat enhancement, predator management, interpretive programs, and scientific research.

The draft plan addresses these key elements:

1. Interim and long-term population goals.

2. Interim and long-term funding needs for planning and implementing the recovery strategy.

3. A range of conservation measures designed to lead to the recovery of the subspecies with flexibility to modify those measures based on research findings and population monitoring results.

4. An estimate of the time required to achieve recovery based on a range of possible management and other recovery actions such as private landowner incentives to protect or enhance habitat.

5. A list of tasks and agency/group responsibilities needed to achieve recovery of the subspecies.

6. A mechanism to monitor the progress of recovery and identify milestones of success or any other actions needed in order to reach stated interim and/or long-term recovery goals, and the flexibility to alter those actions based on new information.

7. Criteria and procedures for changing the status of the subspecies should recovery be achieved or the population and habitat status deteriorate further.

8. A schedule of research and management actions necessary to implement the recovery strategy.

9. List of actions to receive additional funds following completion of the planning phases of the recovery strategy (e.g., research studies, habitat management).

The recovery team and the Department will solicit and consider the input of all affected and interested parties during the development of the recovery strategy plan. After peer review and modification, the Department will present the completed recovery strategy plan to the California Fish and Game Commission for adoption. The Department will assume the responsibility for implementing the plan's actions and recommendations for the recovery of greater sandhill cranes in California.

ACKNOWLEDGMENTS

Many people have participated in the Department's sandhill crane research and management program over the years; I especially wish to acknowledge the valuable contributions of researchers C.D. Littlefield, T.H. Pogson, S.M. Linstedt, G.L. Ivey, and C.P. Herziger. I also wish to thank the several Department employees and others who worked independently or assisted me in collecting field data over 2 decades, including J.A. Estep, B. Deuel, and J. Snowden. The staffs of the Malheur NWR and the Modoc NWR have been active in sandhill crane research and management for many years and their assistance to the Department was invaluable. Some private land owners in the State have implemented management activities on their properties that are sensitive to the needs of cranes. Private sector conservation organizations such as TNC as well as the State's WCB have acquired several key habitats for cranes. The members of the sandhill crane recovery team deserve special note for their efforts in developing a first draft of a recovery strategy for cranes in California. I am grateful for the editorial comments of R. C. Drewien, P. Hofmann, C. D. Littlefield, M. L. Morrison, D. T. Steele, and D.Yparraguirre on drafts of this manuscript.

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